NASA

SECTION 20

STS-107/114 SRB Mission Specific Loads in Support of ET/SRB Aft Attach Ring Material Properties Issue

Loads Panel
1/27/03

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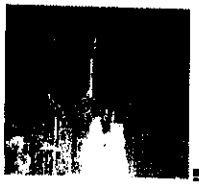
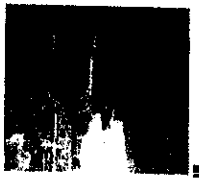
Agenda

- Objectives
- Background
- Liftoff
  - Results (STS-107, STS-114)
  - Summary/Forward Plan
- High-Q
  - Results (STS-107, SLWT Operational High-Q)
  - Summary/Forward Plan
- Back-up



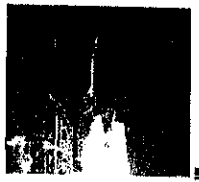
Objectives

- STS-107 mission specific ET/SRB strut and interface load results for Liftoff and High-Q flight regimes
- STS-114 mission specific ET/SRB strut load results for Liftoff flight regime
- Schedule for future results



Background

- **ET/SRB attach ring material properties**
  - Strength testing for ET/SRB attach (ETA) ring determined that material strength properties were lower than required in localized areas
  - Design load case analysis using worst-case material properties resulted in a minimum factor of safety of 1.25. NSTS 07700 requires a minimum safety factor of 1.4 for Space Shuttle general structure.
- **In order to gain some potential relief, the SRB Element requested mission specific ET/SRB strut and interface loads for STS-107**
- **Request for mission specific ET/SRB strut and interface loads repeated for STS-114 and STS-115**
- **No Liftoff SRB indicator exceedances of baseline limits for STS-107 or STS-114**
- **No High-Q SRB indicator exceedances of baseline limits for STS-107 (STS-114 is generically certified)**



Liftoff Results – STS-107

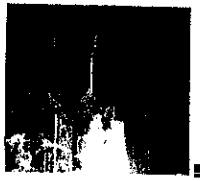
■ Liftoff Flight Regime

- Methodology
  - Results from STS-107 Liftoff FMA (presented to Loads Panel 6/10/02)
  - Load indicator envelope table used to determine max/min values for the ET/SRB aft attach struts (P8/11, P9/12, P10/13) and time of occurrence
  - Determined time consistent complement of strut loads
- Results

	Maximized Strut Indicators					
	P8/11+ (max 165.67)	P8/11- (max –197.07)	P9/12+ (max 207.79)	P9/12- (max –67.62)	P10/13+ (max 68.57)	P10/13- (max –150.65)
P8[kips]			-24.94	-32.01	44.50	-63.87
P9[kips]	15.56	68.61			43.40	62.12
P10[kips]	-42.86	-96.05	-40.11	-75.76		
Time[s]*	7.175	7.061	6.895	7.751	8.169	8.288
Case	LO013	LO347	LO102	LO148	LO672	LO146

* After SSME ignition

- Documented
  - "STS-107 SRB/ET Aft Attach Ring Liftoff Load Environments", 03MA0029, J. A. Kaminsky to G. P. Nielsen, 1/23/03



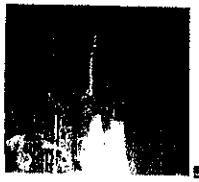
Liftoff Results – STS-114

Liftoff Flight Regime

- Methodology
  - Results from STS-114 Liftoff FMA (presented to Loads Panel 1/6/03)
  - Load indicator envelope table used to determine max/min values for the ET/SRB aft attach struts (P8/11, P9/12, P10/13) and time of occurrence
  - Determined time consistent complement of strut loads
- Results

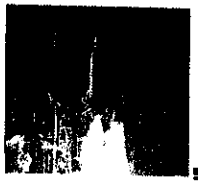
	Maximized Strut Indicators					
	P8/11+ (max 154.24)	P8/11- (max –191.62)	P9/12+ (max 202.82)	P9/12- (max –49.56)	P10/13+ (max 62.08)	P10/13- (max –168.90)
P8[kips]	135.73		-29.77	-46.83	68.69	-73.14
P9[kips]	41.60	71.33			86.77	76.56
P10[kips]	-23.69	-52.34	-45.15	-56.28	-21.68	
P11[kips]		-153.38	-2.23	-57.26	59.38	-70.34
P12[kips]	34.37	61.23	177.79	-18.71	86.18	66.30
P13[kips]	-16.67	-31.80	-12.51	-54.66		-49.29
Time[s]*	7.208	7.458	6.817	7.768	7.550	8.503
Case	LO0776	LO0570	LO0505	LO0561	LO0789	LO0703

* After SSME ignition



Liftoff Summary/Forward Plan

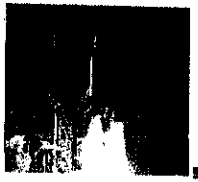
- **STS-107**
  - Mission specific Liftoff ET/SRB aft attach strut loads delivered to SRB element to assist in material strength issue resolution
  - Liftoff flight regime determined to be critical area
- **STS-114**
  - Mission specific Liftoff ET/SRB aft attach strut loads included in this presentation
    - Formal transmittal document (ECD 2/7/03)
- **STS-115**
  - Mission specific Liftoff ET/SRB aft attach strut loads – to coincide with STS-115 Liftoff FMA (ECD 3/3/03)



High-Q Results – STS-107

High-Q Flight Regime

- Methodology
  - Results from STS-107 High-Q mission specific launch probability assessment of operational High-Q qbar design target with Light Weight Tank (presented to SIRB 12/4/02, reviewed with Loads Panel chair 12/6/02, and presented to SSEIG 12/9/02)
  - Investigated SRB/ET aft attach indicators FTB7, FTB8, FTB9, and FTB10 based on initial information to supply "SRB" indicators at aft ET attach ring (assume "ET" indicators, P8 through P13, for future work)
  - Results were not provided to SRB Element as the High-Q case was not the issue driver in the final analysis
  - Launch probability analysis:
    - A batch of 150 non-dispersed trajectories derived from 150 mission specific winds provided by GN&C
    - All load indicators were evaluated for each set of 150 trajectories
    - No violations were encountered



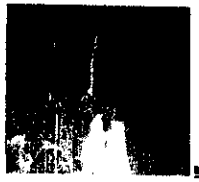
High-Q Results – STS-107

High-Q Flight Regime

- Indicator results for STS-107 mission specific LWT certification (Lbs.)

Launch Probability Loads (Lwt_revr_hiq_ne_op_cert - STS-107)							
Load Indicator	Load Dir	Nom Load	RSS knockdown	Total Load	Limit	% of Limit	Mach
FTB7 (+)	+Z	104544.64	58860.00	163404.64	275900.00	59.23	1.40
FTB7 (-)	+Z	-71488.24	-45569.20	-117057.44	-195000.00	60.03	1.78
FTB8 (+)	+Z	143167.26	40476.90	183644.16	299900.00	61.24	1.35
FTB8 (-)	+Z	-36606.89	-54675.20	-91282.09	-204700.00	44.59	1.18
FTB9 (+)	+Y	1815.67	25768.80	27584.47	269900.00	10.22	1.05
FTB9 (-)	+Y	-108836.26	-40454.40	-149290.66	-300700.00	49.65	1.55
FTB10 (+)	+Y	118695.48	28838.40	147533.88	306800.00	48.09	1.43
FTB10 (-)	+Y	-1484.24	-23138.70	-24622.94	-296000.00	8.32	1.04

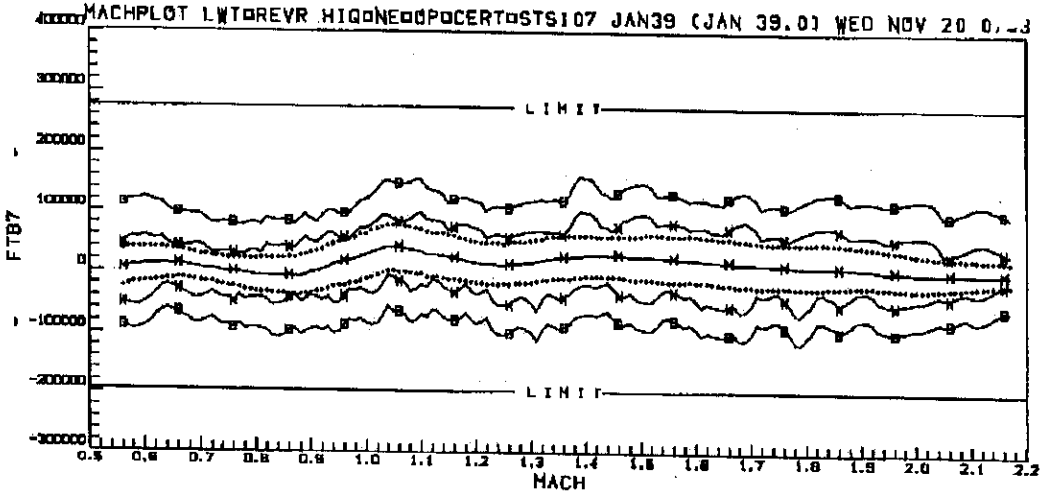
LWT - Total Knockdowns (STS-107)				
Load Indicator	System Disp	Gust	WP	RSS knockdown
FTB7 (+)	52246.70	2836.00	27050.00	58860.00
FTB7 (-)	-34056.40	-4897.80	-29790.00	-45569.20
FTB8 (+)	30054.00	2848.00	27050.00	40476.90
FTB8 (-)	-44933.00	-3414.50	-29790.00	-54675.20
FTB9 (+)	22657.00	718.00	0.00	25768.80
FTB9 (-)	-30079.50	-630.00	-10370.00	-40454.40
FTB10 (+)	24278.10	4344.00	10370.00	28838.40
FTB10 (-)	-19401.20	-7430.00	0.00	-23138.70

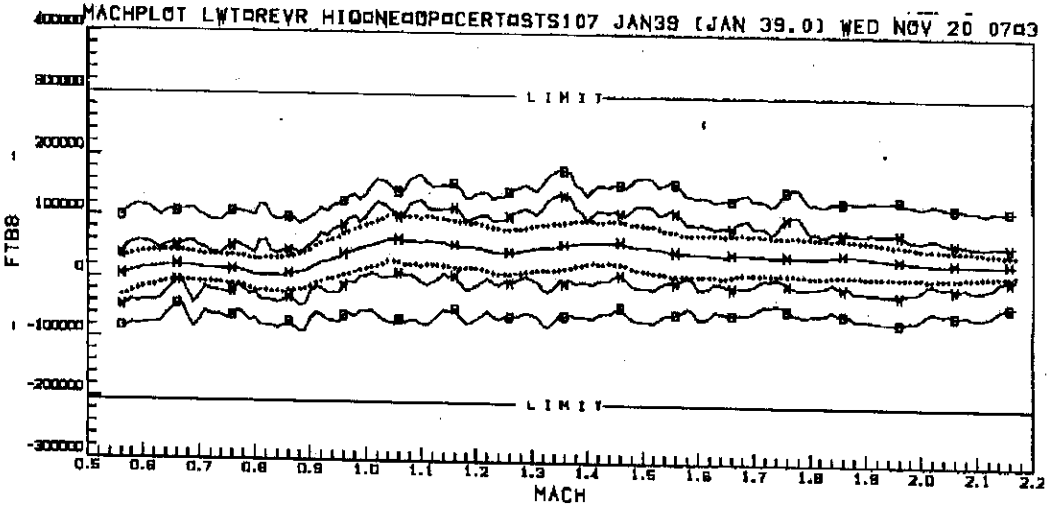


High-Q Results – STS-107

High-Q Flight Regime

- Mach plots for STS-107 mission specific LWT certification (Lbs.)





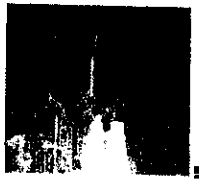
Legend:

..... 95% of winds

M - Undispersed load mean wind of the month

W - Undispersed envelope of 150 winds

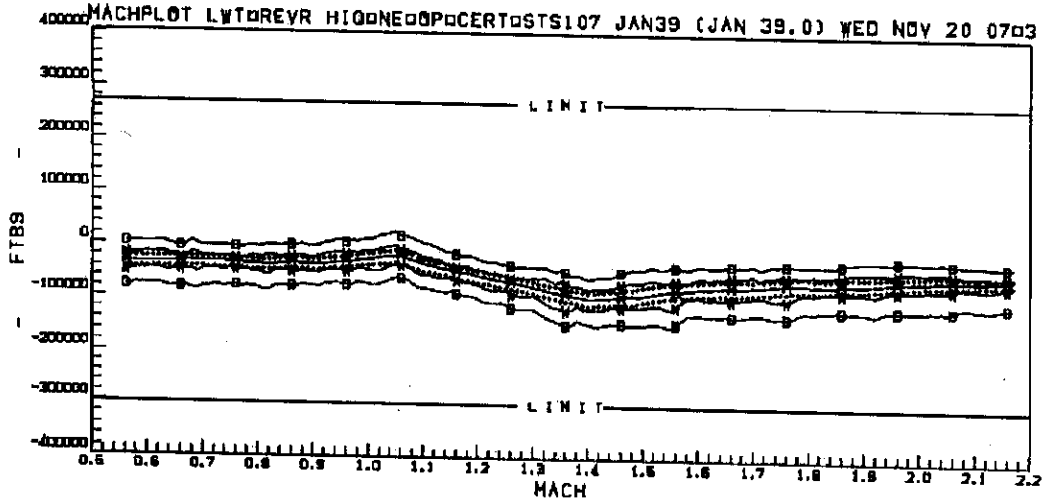
D - Dispersed envelope of 150 winds

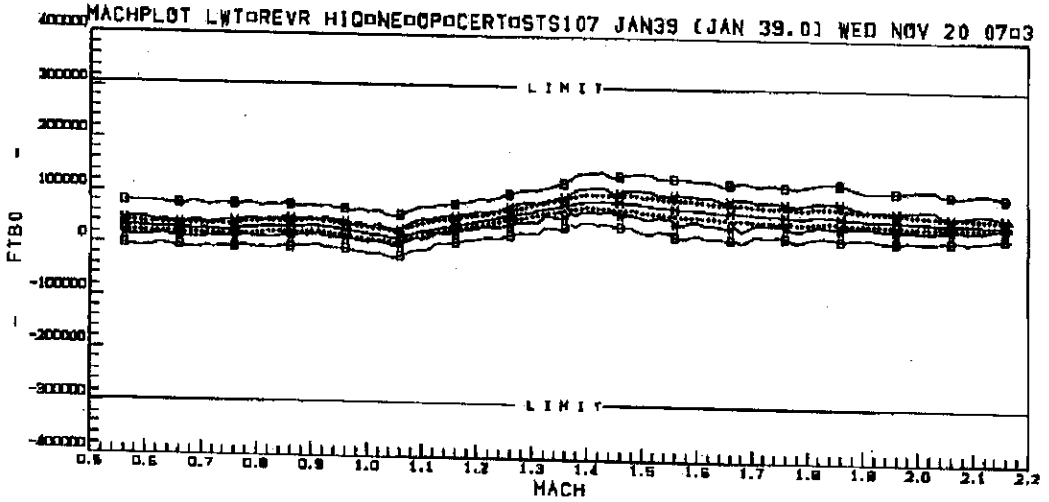


High-Q Results – STS-107

High-Q Flight Regime

- Mach plots for STS-107 mission specific LWT certification (Lbs.)





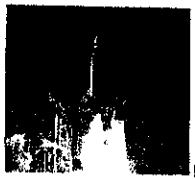
Legend:

..... 95% of winds

M - Undispersed load mean wind of the month

W - Undispersed envelope of 150 winds

D - Dispersed envelope of 150 winds



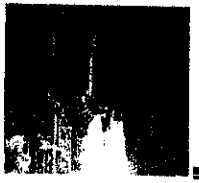
High-Q Results – STS-114 (Compatible)

High-Q Flight Regime

- Indicator results for PE Operational High-Q Certification of SLWT (Lbs.) (March/51 degrees/nominal energy)

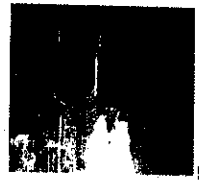
Launch Probability Loads (Slwt _revb_hiq_ne_op_cert - Mar51_y00d045)							
Load Indicator	Load Dir	Nom Load	RSS knockdown	Total Load	Limit	% of Limit	Mach
FTB7 (+)	+Z	114873.53	68207.50	183081.03	284500.00	64.35	1.05
FTB7 (-)	+Z	-64709.14	-55383.30	-120092.44	-193100.00	62.19	0.93
FTB8 (+)	+Z	138808.58	44223.70	183032.28	303000.00	60.41	1.39
FTB8 (-)	+Z	-47195.50	-40284.80	-87480.30	-193900.00	45.12	0.82
FTB9 (+)	+Y	-3027.91	25768.80	22740.89	233600.00	9.73	1.05
FTB9 (-)	+Y	-118860.13	-28102.90	-146963.03	-304400.00	48.28	1.40
FTB10 (+)	+Y	113383.51	34012.40	147395.91	280100.00	52.62	1.47
FTB10 (-)	+Y	-75.77	-23011.20	-23086.97	-276000.00	8.36	1.03

SLWT - Total Knockdowns (Mar51-y00d045)				
Load Indicator	System Disp	Gust	WP	RSS knockdown
FTB7 (+)	55575.00	10226.00	38041.40	68207.50
FTB7 (-)	-37744.40	-7184.80	-38968.10	-55383.30
FTB8 (+)	31056.10	2701.60	31438.90	44223.70
FTB8 (-)	-27162.80	-15703.87	-26312.90	-40284.80
FTB9 (+)	22657.00	8571.00	0.00	25768.80
FTB9 (-)	-21896.70	-16923.00	-13044.20	-28102.90
FTB10 (+)	26953.30	16069.40	17977.20	34012.40
FTB10 (-)	-19472.00	-8804.80	0.00	-23011.20



High-Q Summary/Forward Plan

- **STS-107 (Launch 1/16/03)**
  - Mission specific High-Q ET/SRB interface loads retrieved from launch probability analysis to assist in material strength issue resolution.
- **STS-114 (Launch 3/01/03)**
  - High-Q ET/SRB interface loads retrieved from PE High-Q Operational Certification of SLWT included in this presentation.
  - **TASK A:** Perform mission specific "launch probability" assessment (150 mission specific, non-dispersed trajectories from GN&C) and provide knockdown dispersed P8 through P13 indicator loads. Tabulate Mach consistent loads for max/min of each indicator. (ECD 2/4/03)
  - **TASK B:** Obtain feedback from SRB Element on utility of approach and need for further relief. Identify comparable current certification loads, and prioritize indicators to max/min for which time consistent loads are needed. (ECD 2/10/03)



High-Q Summary/Forward Plan

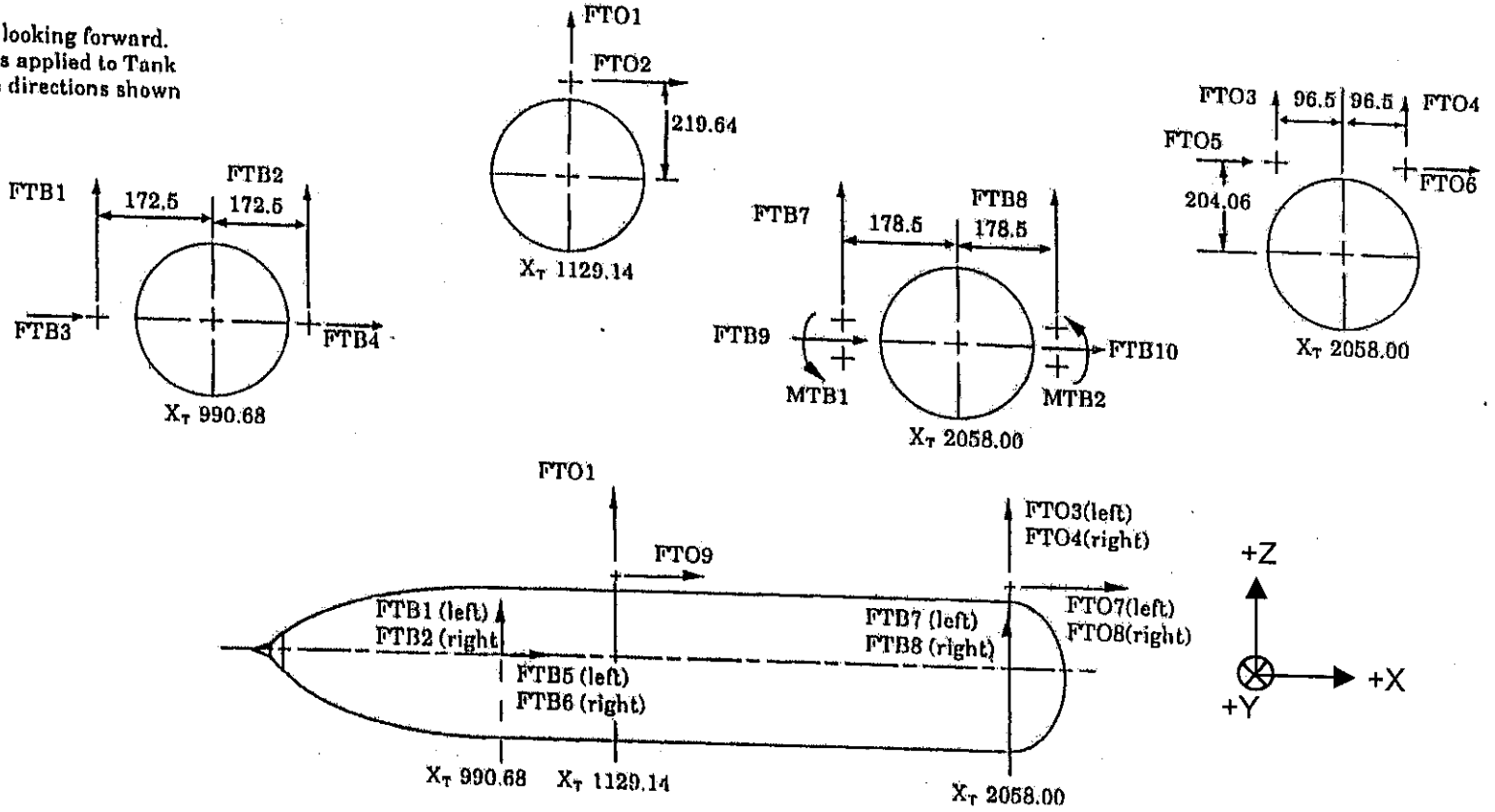
- **STS-114 (continued)**
  - **TASK C:** Perform mission specific, quasi-static time domain assessment to determine time consistent loads with ASCENT code. (ECD 02/27/03)
    - Develop ASCENT inputs based on non-dispersed and dispersed trajectory inputs.
    - Generate mission specific (mass properties) ASCENT math models.
    - Verify that gust dynamics have minimal impact to total load in launch probability assessment to validate quasi-static approach. Otherwise modify inputs or add gust increment to quasi-static results.
    - Proceed on prioritization basis, developing time consistent loads for the selected indicator max or min with the associated set of input conditions.

High-Q Summary/Forward Plan

- **STS-115 (Launch 5/23/03)**
  - Perform mission specific "launch probability" assessment (150 mission specific, non-dispersed trajectories from GN&C) and provide knockdown dispersed P8 through P13 indicator loads. Tabulate Mach consistent loads for max/min of each indicator. (ECD 3/11/03)
    - Note that FRR TDDP is not released until 03/28/03
  - Perform mission specific, quasi-static time domain assessment to determine time consistent loads with ASCENT code. (ECD 04/03/03)
  - Develop time consistent gust loads with ASCENT to be added to quasi-static cases. (ECD 04/21/03)

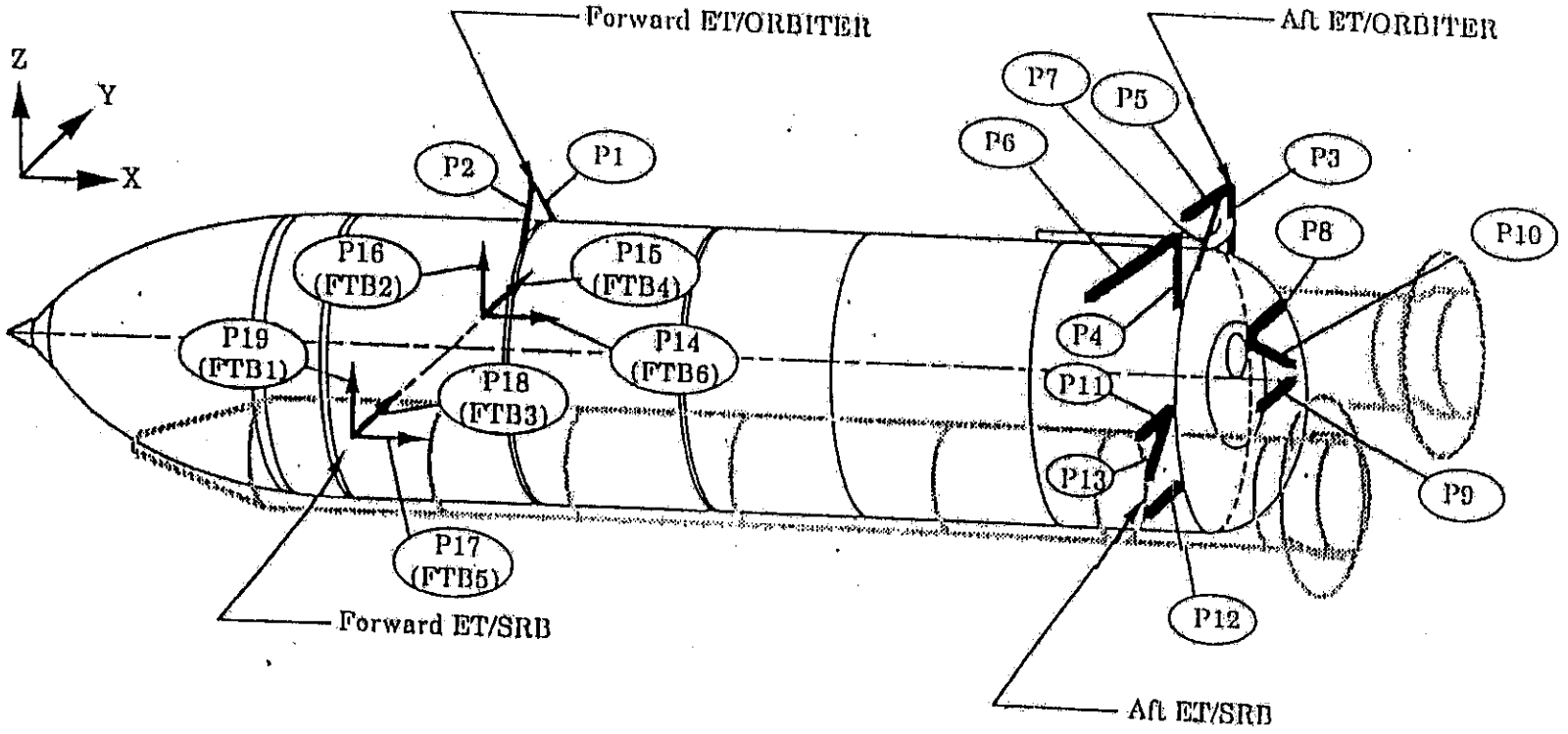
Interface Loads Diagram

Section looking forward.
All loads applied to Tank
Positive directions shown



Back-up

Strut Loads Diagram



STS-107 External Tank Attach Ring Analysis

Steve Brolliar

January 27, 2003

SA-PRES-01714-2003

USA SRB Element

STS-107 External Tank Attach Ring Analysis

Objective

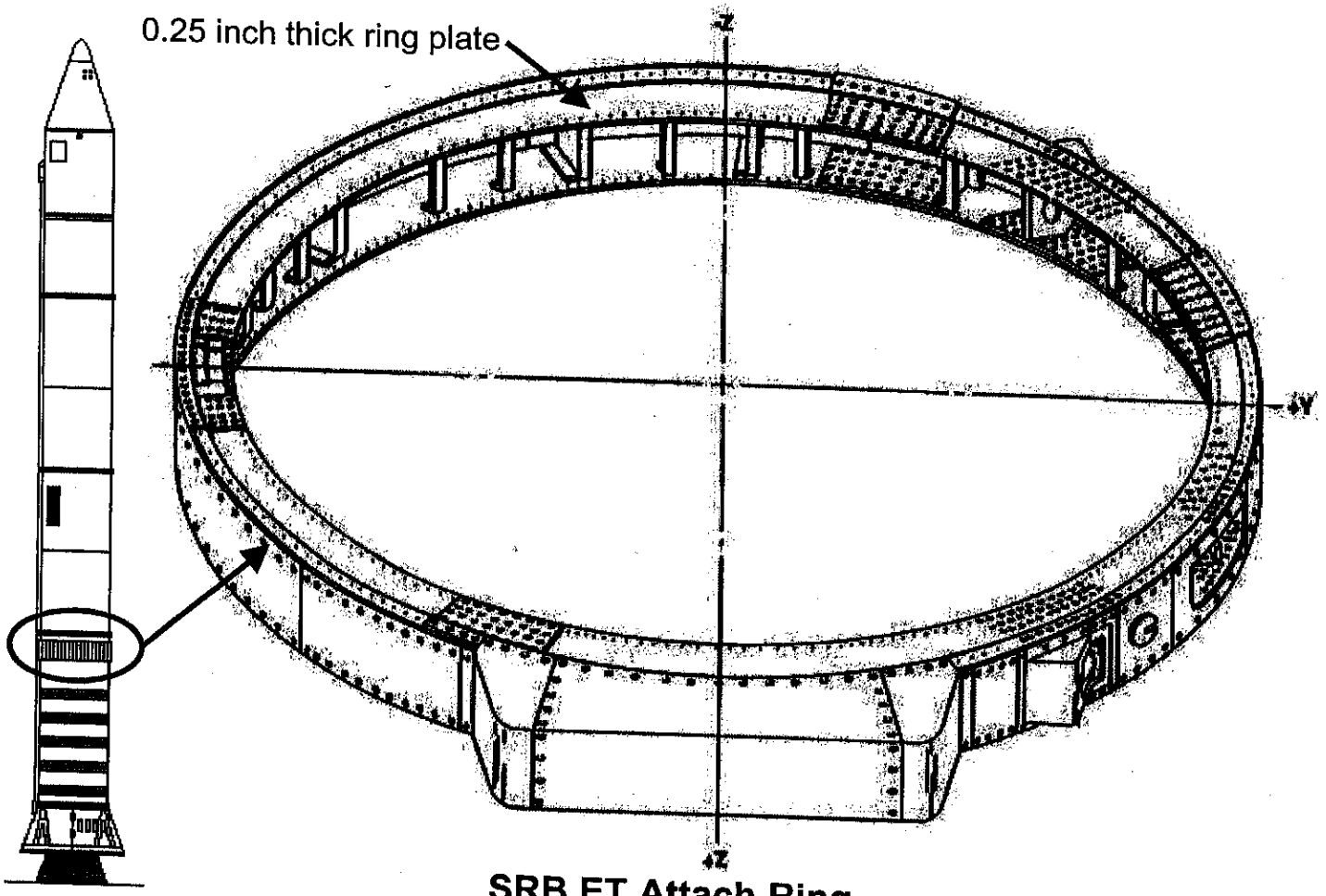
- To present the background for the SRB ETA ring technical issue worked for STS-107
- To discuss the work being performed to clear ETA rings for flight
- To request additional load information needed to clear the next two sets of ET attach rings for flight

STS-107 External Tank Attach Ring Analysis

Background

- The ETA ring plate is 4130 steel per MIL-S-18729
- Better characterization of the fracture properties was needed
- Scrapped ETA ring material (S/N 13) was available for testing
- Testing revealed reduced material strength capability
  - Ultimate tensile strengths from 152 to 202 ksi
  - Yield tensile strengths from 130 to 189 ksi
- Minimum requirement for 4130 is 180 ksi ultimate and 163 yield
- 8 tensile specimens out of 20 were below the 180 ksi minimum
- Similar results were obtained from tests performed on a buckled ETA ring (S/N 9) during the mid-1980s
  - 6 tensile specimens utilized
  - Low strength results were thought to have been caused by localized residual stresses from material buckling
  - Limited hardness testing performed on each ring was used to clear the fleet

STS-107 External Tank Attach Ring Analysis



SRB ET Attach Ring

STS-107 External Tank Attach Ring Analysis

ETA Ring Analysis for STS-107

- Lowest margin of safety locations are the splice plate mounting holes
- Analysis was modified to use 147 ksi for the ultimate tensile strength and 130 ksi for the yield strength
  - Lowest measured results from the 26 samples (including the mid '80s testing)
- Revised minimum factors of safety were calculated
- The required 1.4 factor of safety on ultimate and 1.1 on yield was not met
- A waiver was requested to allow a 1.25 minimum factor of safety on ultimate
- The minimum margin was for the liftoff flight regime
- STS-107 flight specific liftoff loads were used to determine a flight specific liftoff minimum factor of safety to provide additional flight rationale
  - Flight specific strut loads used (provided by Boeing)
  - 60 degree F PMBT pressure data used (provided by Thiokol)
- Due to the time available additional flight regimes were not checked to see if the reduced material margins were below the flight specific liftoff value

STS-107 External Tank Attach Ring Analysis

Testing

- The ETA ring was qualified using 140% design loads during STA-3 in 1987
  - Combined RSRM case pressure and strut loads were used
    - Liftoff test strut loads and motor pressure
      - P8 = -110.6 kips
      - P9 = 388.3 kips
      - P10 = -36.4 kips
      - Motor Pressure = 1316.53 psig
    - Max Q test strut loads and motor pressure
      - P8 = -263.2 kips
      - P9 = 327.3 kips
      - P10 = -437.7 kips
      - Motor Pressure = 911.42 psig
  - S/N 23 utilized as static test article for qualification
    - Manufactured using same processes and materials as S/N 1-26

STS-107 External Tank Attach Ring Analysis

Flight Inspection

- Selected fastener holes in each ETA ring ultrasonically inspected periodically based on analysis
  - Holes inspected based on worst loading
  - No cracks attributed to flight loads found
- Highest stressed area are stripped and visually inspected for damage after each flight
- Critical dimensional checks performed after each flight revealed no anomalous conditions with ETA rings installed on STS-107

STS-107 External Tank Attach Ring Analysis

History

- No damage noted in the history of ETA rings due to ascent loads
  - No cracked holes identified during any previous testing/inspection
  - No flight load induced deformations identified in previous 112 missions
- ETA ring design life is 40 missions
  - STS-107 ETA ring mission count

S/N	Total flts	Post STS-51L	# > STS-107 case pressure
6	12	9	5
19	9	8	3

STS-107 External Tank Attach Ring Analysis

Near Term Flights

- STS-114 and STS-115 rings cannot be inspected/tested without a major schedule impact
- The minimum ultimate factor of safety for STS-114 and STS-115 using design loads is 1.27
  - The minimum factor of safety occurs during the liftoff flight regime
- Rationale similar to STS-107 will be needed to support waiving the factor of safety requirement
  - Mission specific strut loads will be needed
  - Mission specific motor pressure may be required depending on the PMBT
- The minimum factor of safety for other flight regimes is in work
  - Will define whether the mission specific liftoff factor of safety is the overall minimum
- 4130 fracture property identification work is continuing
  - Safe-life is expected to be negatively impacted when fracture properties are available

STS-107 External Tank Attach Ring Analysis

Near Term Flights (cont.)

- SRB currently certified to "Tulon spectrum" developed by MSFC and updated by USA-SRB in August 2001
  - Prior to approval of fracture spectra updates, Loads Panel requested SRB compare the BRSS IVBC-3 spectrum for P9 to the updated spectrum
  - BRSS provided the 40 mission P9 and P10 spectra for assessment
  - Analysis performed on critical strut hardware showed at least 10 times more life for BRSS P9 spectrum
  - Loads Panel approved USA-SRB fracture spectra update
- For ETA Ring fracture analysis, all 3 strut components are needed
  - 40 mission P8 spectra will be needed for analysis
- Use of BRSS IVBC-3 spectra is expected to show additional life for fracture critical areas of ETA Ring
- Any modifications to or use of the IVBC-3 spectra will be coordinated with MSFC and the Loads Panel

STS-107 External Tank Attach Ring Analysis

Future Flights

- Work is being performed to identify requirements for future flights

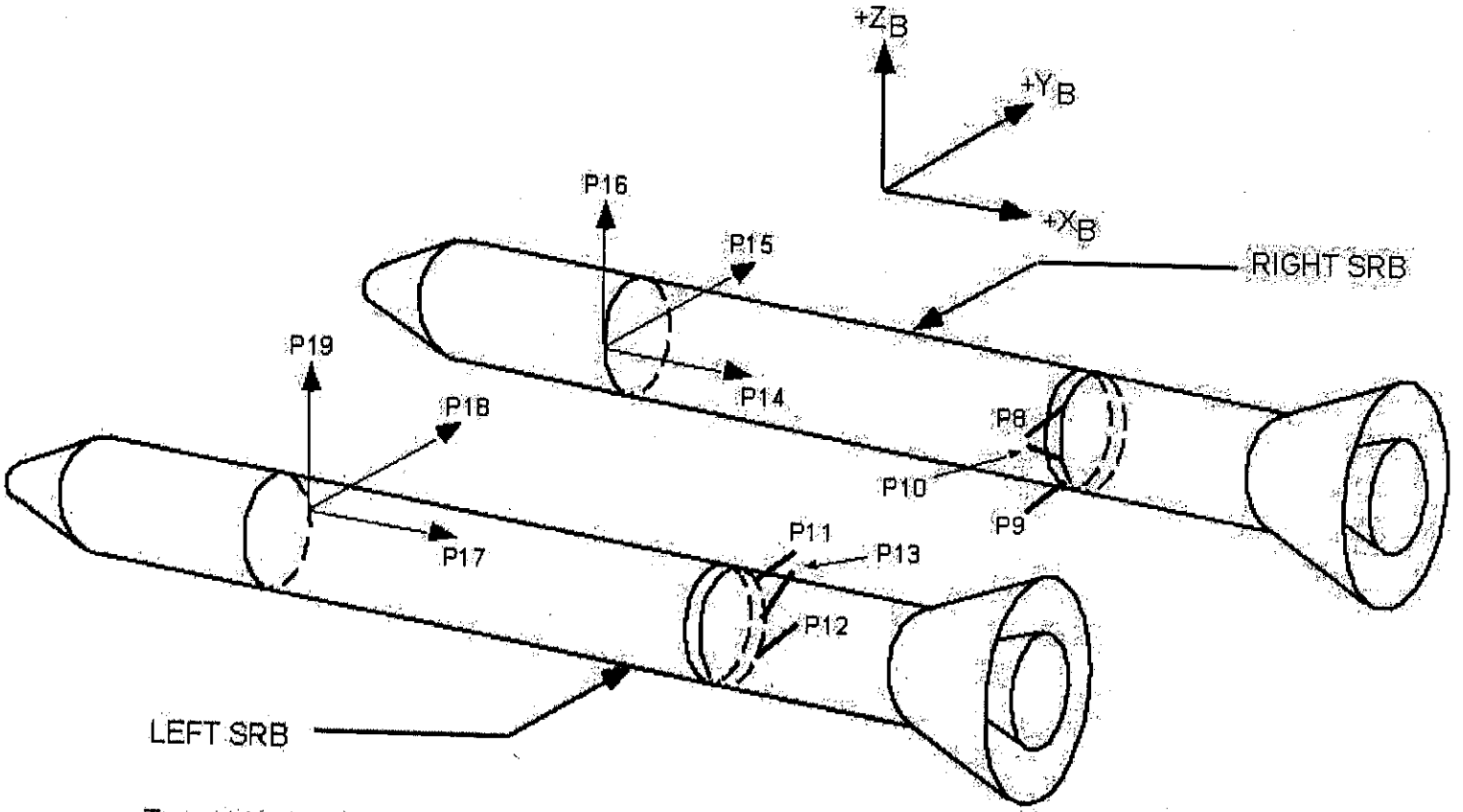
STS-107 External Tank Attach Ring Analysis

Recommendation

- Approve development of flight specific Liftoff loads for STS-114 and STS-115
  - USA Systems Integration contacted to request flight specific loads
  - A request for any additional flight regimes will be made through USA Systems Integration and followed up with a Loads Panel presentation
- Approve delivery of 40 mission P8 IVBC-3 spectra

STS-107 External Tank Attach Ring Analysis

Backup



Truss Members: P8 to P13
are Positive in Tension,
Negative in Compression

Orthogonal Loads: P14 to P19
have Positive Directions Shown
(Loads Applied to SRBs)

CR # CR S091496	**EA Change Evaluation Request**	Page 1 of1

CHANGE TITLE SRB ETA RING STRUCTURE FACTOR OF SAFETY

EVALUATION / RESPONSE DUE	EVALUATED BY / OFFICE / PHONE NO
02/04/03	Rodney Rocha/ES2/38889

SELECT TYPE

- ☒ CHANGE REQUEST (CR)
- ☐ FLIGHT RULE # _____
- ☐ SHUTTLE – LEVEL II
- ☐ EVA
- ☐ FCE / GFE
- ☐ EDCP / OCR

DISPOSITION

- ☒ APPROVE
- ☐ NO COMMENTS/ NO ISSUES
- ☐ APPROVE w/Mods (must provide specific document revisions, i.e., From/To's)
- ☐ DISAPPROVE (must provide rationale)
- ☐ NOT APPLICABLE

FUNDING SPLIT BETWEEN FISCAL YEARS? ☐ No ☐ Yes (FY /FY)

WORK TO BE PERFORMED ☐ In-House ☐ Contractor

TYPE OF CONTRACT: ☐ SEAT ☐ ID/IQ ☐ Other, Specify:

Description of Task

Indicate appropriate response type

☒ SHUTTLE EVALUATION ☐ STATION EVALUATION ☐ ROM

DCE Concurrence Required for Shuttle Evaluation

SYNOPSIS OF INVOLVEMENT/BACKGROUND:

Reviewer is DCE for JSC Structural Engineering Div. and Technical Manager for the Space Shuttle Loads & Dynamics Panel (supporting MS/Systems Integration). Heard the verbal flight rationale from SRB Project at the STS-107 pre-launch Tanking Meeting.

COMMENTS/REMARKS:

Though I approve, it must be pointed out that there was no technical data presented to the technical forum of the Space Shuttle Loads & Dynamics Panel, a situation which is not typical and contrary to Shuttle Program requirements. The issue was identified only hours before the Tanking Meeting. SSP management assumed full risk for launch without a full technical review occurring first.

IMPACT DESCRIPTION:

STS-107 launch would have been delayed.

ITA #	ROM Cost	ROM Schedule

EVALUATOR Rodney Rocha	DATE 01-28-03
DIVISION ES	DATE
EA2/4	DATE

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Friday, January 31, 2003 12:25 PM
To: 'Hoffman, Thomas L'; 'Goodmark, Jeffrey A'
Cc: CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA); CHANG, YUAN-CHYAU, PHD (HARRY) (JSC-ES3) (NASA)
Subject: STS-107 Landing

Tom and Jeff,
I am planning to go the Mission Eval. Room (MER) around 6:45 AM Saturday and join the Landing Team, the Mechanical Team, and/or the Thermal Control Systems team consoles. I am interested in monitoring the real time temperature data from the wheels, landing struts, hydraulic brake lines, and also the tire pressures--with emphasis on the left hand side, and comparing such data output/trends to the right side. This is, of course, related to the ET insulation debris striking the left wing underside during ascent at Mach = 2.6 (81 seconds after launch). As you may know, the NASA/USA/Boeing contractor team made up of multiple technical disciplines performed conservative analyses and we showed no safety-of-flight concerns.

But, I am interested nevertheless in the critical landing and structural/mechanical systems and their real time data displays, such as temperature and pressure. Thanks.

P.S. Question to Harry Chang: Are there real time temp. data displays for the (underside only, not top) wing structure? For example, wing spar caps, skins, RCC panels, etc. Thanks.

odney Rocha
Structural Engineering Division (ES-SED)
* ES Div. Chief Engineer (Space Shuttle DCE)
* Chair, Space Shuttle Loads & Dynamics Panel
Mail Code ES2 Phone 281-483-8889

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Tuesday, January 21, 2003 8:49 AM
To: 'Prabhakar, Ashok '
Subject: STS-107 wing strike by ET insulation

Ash,
Are you or someone at ET Project following or supporting the Orbiter issue of the piece of debris (ET foam from the forward bi-pod?) striking the wing? Our Boeing system integ. engineers are performing transport analysis and our Boeing Loads/Stress may invoke previous test data of such insulation impacting TPS. Were or are you part of providing such test data or insulation properties (mass density, restitution, typical debris sizes, etc.)? I know Boeing is talking to someone at ET. I will bring subject up at Monday's Loads Panel (Jan. 27) Thanks.

Rodney Rocha
Structural Engineering Division (ES-SED)

- **ES Div. Chief Engineer (Space Shuttle DCE)**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Mail Code ES2 Phone 281-483-8889

Michele Lewis

From:	ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent:	Sunday, January 26, 2003 8:45 PM
To:	SHACK, PAUL E. (JSC-EA42) (NASA); MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); OUELLETTE, FRED A. (JSC-MV6) (NASA)
Cc:	ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); KRAMER, JULIE A. (JSC-EA4) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)
Subject:	STS-107 Wing Debris Impact on Ascent: Final analysis case completed

As you recall from Friday's briefing to the MER, there remained open work to assess analytically predicted impact damage to the wing underside in the region of the main landing gear door. This area was considered a low probability hit area by the image analysis teams, but they admitted a debris strike here could not be ruled out.

As with the other analyses performed and reported on Friday, this assessment by the Boeing multi-technical discipline engineering teams also employed the system integration's dispersed trajectories followed by serial results from the *Crater* damage prediction tool, thermal analysis, and stress analysis. It was reviewed and accepted by the ES-DCE (R. Rocha) by Sunday morning, Jan. 26. The case is defined by a large area gouge about 7 inch wide and about 30 inch long with sloped sides like a crater, and reaching down to the densified layer of the TPS.

SUMMARY: Though this case predicted some higher temperatures at the outer layer of the honeycomb aluminum face sheet and subsequent debonding of the sheet, there is no predicted burn-through of the door, no breeching of the thermal and gas seals, nor is there door structural deformation or thermal warpage to open the seal to hot plasma intrusion. Though degradation of the TPS and door structure is likely (if the impact occurred here), there is no safety of flight (entry, descent, landing) issue.

Note to Don M. and Fred O.: On Friday I believe the MER was thoroughly briefed and it was clear that open work remained (viz., the case summarized above), the message of open work was not clearly given, in my opinion, to Linda Ham at the MMT. I believe we left her the impression that engineering assessments and cases were all finished and we could state with finality no safety of flight issues or questions remaining. This very serious case could not be ruled out and it was a very good thing we carried it through to a finish.

Rodney Rocha (ES2) x38889

- **Division Shuttle Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Michele Lewis

From: CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)
Sent: Friday, January 31, 2003 4:58 PM
To: GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)
Cc: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Subject: WAR

SPACE SHUTTLE ORBITER
STS-107 Debris Impact Damage
In order to alleviate concerns regarding the worst case scenario which could potentially be caused by the debris impact under the Orbiter's left wing during launch, EC was requested by ES2 to conduct some landing simulations on the Ames Vertical Motion Simulator which tested the ability of the crew and vehicle to survive a condition where two main gear tires are deflated before landing. The results, although limited, showed that this condition is controllable, including the nose slap down rates. These results may give MOD a different decision path should this scenario become a reality. Previous opinions were that bailout was the only answer.

Michele Lewis

From: CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)
Sent: Friday, January 24, 2003 4:46 PM
To: GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)
Cc: FEARER, JANICE A. (JAN) (JSC-ES2) (NASA); ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Subject: WAR

SPACE SHUTTLE ORBITER
Antiskid/Brake Control Electronic Box
The current STS-107 flight is the second time that this vehicle has flown with one of the two the brake boxes having a loose handle. The "U" shaped handle is normally attached with two pan head screws, but the handle is currently tied down with safety wire to prevent further loosing of the screws which could potentially come completely loose, fall out into the electronic box, and cause improper brake/skid control commands. Upon completion of this mission, there is a long down time for this vehicle, and the vendor will come to KSC to open the box and tighten the screws.

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Wednesday, January 29, 2003 4:13 PM
To: GOERNER, LAURA (JSC-EA) (NASA)
Cc: SHACK, PAUL E. (JSC-EA42) (NASA); HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA); PREVETT, DONALD E. (DON) (JSC-EP) (NASA); ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)
Subject: SRB Neg. Margin Issue, Information for Frank Benz

Laura,
As per Frank's request this morning, please provide this information to him on this subject. Thank you.

SUMMARY

- Negative margins (equivalent to factor-of-safety reduction to FS = 1.25; requirement is FS = 1.4) are real and based on recent materials properties testing. May be caused by improper heat treatment. Affects struc. margins calculated against lift-off and ascent flight design loads and struc. life remaining in hardware.
- Aft ring structure is the critical structure where attach struts are mounted between SRB and ET. See picture in attached briefing.
- SRB Project has requested MS/Systems Integration (through the EA Shuttle Loads & Dynamics Panel) to provide flight specific lift-off limit loads: I.e., based on unique mass & stiffness properties, cargo manifest/coupled dynamics, and bulk propellant temperature from Thiokol (affects internal case pressure contribution to loads).
- Roll maneuver is not a critical case.
- Ascent (Hi-Q= high dynamic pressure) loads needed too, but there may be mitigation here based on the way we protect all load indicators for Orbiter and ET. We are looking at this. There some task options (ascent only) which lead to reduction in day-of-launch probabilities, but we are trying to avoid these if possible since SSP probably would consider this only as last resort.
  Such flight specific limit loads are definitely needed for STS-114 and maybe several more flights. Loads Panel hears their specific requests and status at the Feb. 3 Loads Panel.

Rodney Rocha
Structural Engineering Division (ES-SED)
- **ES Div. Chief Engineer (Space Shuttle DCE)**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Mail Code ES2 Phone 281-483-8889

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Friday, January 24, 2003 4:46 PM
To: GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Subject: Weekely Activity Report

Weekly Activity Report
January 24, 2003

SPACE SHUTTLE:
The ES-Division Chief Engineer and Technical Manager of the Shuttle Loads Panel (R. Rocha) worked technical issues for:

- Cracked Ball Strut Tie Rod Assembly cracked ball found on OV-103 and its implications to other vehicles. Pre-flight worst case geometric configurations were assessed by the Boeing Loads/Stress subsystem manager to identify potential structural negative margins driven by design certification load cases combined with uncertainties of material properties, worst case ball orientation, and severe cracks observed in the test program causing reduced cross-sectional area. Boeing is developing more realistic configurations for continuing assessments and develop screening criterion for any future cracked balls discovered in flight vehicles, and to add analysis products to help the decision process on repairing OV-103 or not.
- STS-107 SRB structural negative margins for the aft attach ring attach points to the ET were accepted by the mission management team via waivers granted by the Space Shuttle Program. These negative margins exist for lift-off and ascent load cases. The Shuttle Loads Panel will hear this subject on January 27 and concentrate on the extent of the problem, the qualification test program, and SRB Project's need for new flight-unique load sets to help clear future flights.
- Multi-discipline technical serial USA/Boeing analyses to assess the STS-107 ET insulation debris striking the OV-102 left wing underside was reviewed. Results from conservative cases investigating portions of the wing showed no wing burn-throughs and no safety of flight issue (for entry, descent, and landing). However, there remains open work to assess the main landing gear doors and seals.

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Tuesday, January 21, 2003 12:09 PM
To: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); MARAIA, ROBERT J. (JSC-ES1) (NASA)
Cc: GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)
Subject: Weekly Activity Report

Weekly Activity Report
January 21, 2003

SPACE SHUTTLE:
The ES-Division Chief Engineer and Technical Manager of the Shuttle Loads Panel (R. Rocha) worked technical issues for:

- Cracked Ball Strut Tie Rod Assembly cracked ball found on OV-103 and its implications to other vehicles. Pre-flight worst case geometric configurations were assessed by the Boeing Loads/Stress subsystem manager to identify potential structural negative margins driven by design certification load cases combined with uncertainties of material properties, worst case ball orientation, and severe cracks observed in the test program causing reduced cross-sectional area. Boeing is developing more realistic configurations for continuing assessment and to add analysis products to help the decision process on repairing OV-103 or not.
- STS-107 SRB structural negative margins for the aft attach ring attach points to the ET were accepted by the mission management team via waivers granted by the Space Shuttle Program. These negative margins exist for lift-off and ascent load cases. The Shuttle Loads Panel will hear this subject and concentrate on the extent of the problem, the qualification test program, and SRB Project's need for new flight-unique load sets to help clear future flights.

Michele Lewis

From: GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)
Sent: Monday, January 27, 2003 4:15 PM
To: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Subject: Activity Report

Structures and Dynamics Branch
Weekly Activity Report
January 27, 2003

SPACE SHUTTLE - Structural Engineering Division (SED) analysis of a severely cracked 2.24-inch diameter ball strut tie rod assembly (BSTRA) ball demonstrates full closure of the crack flanks. The analysis assumes no friction on the crack flanks and a crack orientation parallel to the loading direction. The results for the previous analysis of a 0.2-inch radial crack in a 2.24-inch ball demonstrated a small region of crack opening that was consistent with the tensile stress field from the un-cracked ball analysis results. Prediction of complete crack closure for the case of a severely cracked ball is logical since the remaining ligament is very compliant and acts as a hinge. The rotation and displacement required to close the crack flanks occurs at very low load levels. The results also demonstrate the constraint influence of the BSTRA cups on the displacement field extends beyond the ball-to-cup contact interface into the equatorial region. This analysis may support a decision to fly OV-103 without repairing the cracked BSTRA ball. (Patin)

SED reviewed multi-discipline technical analyses performed by Boeing to assess the STS-107 external tank (ET) insulation debris impact on the underside of the left wing. Results from conservative damage estimate cases showed no wing burn-through and no safety of flight issue for entry and landing. (Rocha)

SPACE STATION - SED has discovered the timeline sequence for solar alpha radiator joint (SARJ) deployment and checkout has been changed from the original plan reflected in the hardware certification. The revised plan shows that SARJ deployment and rotation occurs before installation of the SARJ structural braces and alpha joint interface struts (AJIS). These struts and braces enable necessary changes to the load path from the launch configuration to the on-orbit configuration. The applicable hazard report states "The crew will not proceed with the removal of the 16 SARJ launch locks or the 6 SARJ launch restraints until all four AJIS struts are rigidized." SED also reviewed the flight rule on docked load constraints for SARJ and found it requires modifications. In order to ensure that these rotary joint mechanisms operate properly for the life of the program, the proper installation sequence must be followed. The 12A Flight Operations Review (FOR) is scheduled for the week of January 27. SED will submit a discrepancy notice (DN) to request reinstatement of the original SARJ deployment timeline. (King)

SED met with the advanced resistive exercise device (ARED) engineers to review progress on vibration isolation system (VIS) and design modifications to meet micro gravity requirements. SED provided analysis equations for an alternative VIS design. SED requested that an alternative design with all major vibration modes less than 0.2 Hertz be ready before the end of January. (James)

The internal wireless instrumentation system (IWIS) data from the cycle ergometer with vibration isolation system (CEVIS) development test objective (DTO) is on the ground. However, funding has to be acquired to

have the data decoded, due to the IWIS software problems. This data may also be critical to resolving the ARED micro gravity issues. (James)

FOR INFORMATION ONLY FROM THIS POINT....

SPACE SHUTTLE - The OV-102, STS-107 flight marks the second time that this vehicle has flown with one of the two antiskid-brake control electronics boxes having a loose handle. The "U" shaped handles are normally attached with two pan head screws. One handle on the OV-102 unit is currently tied down with safety wire to prevent further loosening of the screws. Loss of a screw inside the box could potentially cause improper braking or skid control commands. Following STS-107, there is a long down time planned for OV-102 during which the vendor will open the box and tighten the screws. (Campbell)

STS-107 solid rocket booster (SRB) structural negative margins for the aft attach ring attach points to the external tank (ET) were accepted by the mission management team via waivers granted by the Space Shuttle Program. These negative margins exist for lift-off and ascent load cases. The SED Shuttle Loads Panel will review this subject on January 27 and concentrate on the extent of the problem, the qualification test program, and SRB Project's need for new flight-unique load sets to help clear future flights. (Rocha)

The Mechanical Systems Working Group (MSWG) is investigating use of pip pins in a mini-pressurized logistics module (MPLM) carrier. The hardware owner is requesting advice on a future purchase of pip pins to replace ones already in use showing negative margins-of-safety. Further information and analysis is being reviewed prior to issuing a MSWG response. (Davis)

'ACE STATION - The beta gimbal assembly (BGA) team, led by SED, is continuing efforts to understand the BGA anti-rotation latch failures that occurred on a unit undergoing acceptance testing at Boeing, Canoga Park. A status presentation was made to the Vehicle Control Board (VCB) on January 22. The team reported that the testing thus far has not found a reproducible cause for the failure. The latch was brought to Boeing, Houston for further toggle testing. The testing is to be completed by the end of January. The team has been working with Mission Operations Directorate (MOD) to ensure there are adequate procedures to resolve the problem on-orbit, if necessary. (Davis)

SED supported discussions with Boeing loads and dynamics engineers regarding whether the BGA's will be locked or unlocked for mission 12A and 12A.1. Discussions were also held with MOD to coordinate the desired BGA configurations so they can be included in the rules and procedures for those flights. (Davis)

SED is continuing support of meetings to discuss potential integrated motor controller assembly (IMCA) thermal issues due to possible hot and cold temperature limits being exceeded on-orbit. (Davis)

In the building 49 general vibration laboratory, acceptance vibration tests were completed on the Station slide wire assembly. The scheduled test for the X-38 forward trunnion pin was delayed two days for paperwork completion. This test should begin January 27. (Gillette)

INTSITUTION - A preliminary meeting was held with Lockheed to discuss a potential excess capacity acoustic test on the Boeing Delta IV rocket fairing. Action items were assigned to determine the feasibility of doing this test. A similar test was conducted prior to closing the building 49 acoustic test facility. The Boeing Delta IV 'ustic test manager in California will be contacted to obtain more requirement details. (Gillette)

SED conducted a next generation micro-wireless instrumentation system (WIS) design review on the phase 2 design package and schedule. The review was supported by Avionics Systems Division and the Glenn Research

Center contracting officer's technical representative (COTR). The purpose was to ensure the project considered the appropriate design questions and to prepare the team for upcoming test requests. The review generated good questions and resulted in positive remarks on the design package. It was agreed that a separate meeting would e needed to discuss test planning and documentation. (Studor)

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Friday, January 24, 2003 12:58 PM
To: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Cc: GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)
Subject: Overtime Request: 8 hours total

Joe,
Justifications:

- 4 hours last week: Support to STS-107 pre-launch issues: BSTRA balls; late breaking news of the SRB negative margin and subsequent support at the midnight Tanking Meeting; review and evals. of numerous Orbiter CRs, certs., CARs
- 4 hours: Support to on-orbit STS-107 issues: Wing debris impact damage; review of numerous Orb. certs, CARs, CRs
- 8 hours total from above

Rodney Rocha
Structural Engineering Division (ES-SED)
- **ES Div. Chief Engineer (Space Shuttle DCE)**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Mail Code ES2 Phone 281-483-8889

Michele Lewis

From: FEARER, JANICE A. (JAN) (JSC-ES2) (NASA)
Sent: Tuesday, January 21, 2003 10:57 AM
To: MARAIA, ROBERT J. (JSC-ES1) (NASA); STUBBLEFIELD, MELITA I. (JSC-ES1) (NASA)
Cc: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)
Subject: ES2 WAR-STRUCTURES AND MECHANICS DIVISION

Structures and Dynamics Branch

Weekly Activity Report

January 21, 2003

SPACE SHUTTLE - OV-104 is due for replacement of nose wheel axle bearings and grease after 10 years and 20 flights. JSC thermal vacuum tests of this grease exhibited three times the mass loss when compared to different grease used in the main wheel bearings for only one flight. SED recommended an evaluation of the lubricating properties of OV-104 nose axle grease, which has nearly 20 weeks of on-orbit exposure during its lifetime. At SED's request, the grease vendor, Anderol of New Jersey, has agreed to test the OV-104 flown grease at no cost to NASA. The bearings will be removed in March 2003 and one will be sent to Shell for testing. Results will be used to re-evaluate servicing requirements of the wheel bearings.

SED is leading an effort to develop instrumentation to measure power reactant storage and distribution (PRSD) flexline environments. The instrumentation required includes standard micro-wireless sensors and some modifications to existing sensors, as well as a relay node to perform command and data relay functions from the sensors (located under the payload bay liner) to externally operated transceivers in a laptop computer. The SED proposal will include a ground-test on an orbiter for flexline dynamic model validation and one flight of fully instrumented PRSD flexlines at the 527 bulkhead, where the initial cracked flexline was discovered.

SPACE STATION - In preparation for a stage extra-vehicular activity (EVA), the S1 thermal radiator rotary joint (TRRJ) was rotated 20 degrees to provide access to the pump module assembly. After the rotation the TRRJ was locked. During the locking sequence, there was a gear-tooth "crash" which occurs when the gear on the drive-lock assembly (DLA) does not mesh with the bull gear on the TRRJ bearing assembly. The pre-planned tooth crash recovery sequence was used to resolve the situation. Tooth crash is expected to be a common occurrence throughout the life of the ISS. The S1 TRRJ was rotated back to the null position on January 17. During the stage EVA, the crew released the remaining P1 radiator beam launch locks to allow the P1 TRRJ to rotate. During the P1 TRRJ checkout, both hard stops at the end of rotation were verified and the shutdown sequence was performed. The shutdown failed because the program unique identifier for the zero position was incorrect. This also resulted in a gear-tooth crash and recovery on the P1 TRRJ. The checkouts were considered successful and the TRRJ assemblies are ready for mission 12A.1 when they will become fully operational.

SED is working with Boeing to assess a potentially serious situation with internal wireless

instrumentation system (IWIS) replacement batteries. IWIS data will be required to resolve predicted micro-gravity issues caused by a 0.2-Hertz vibration mode for the ISS assembly complete configuration. The currently planned supply of IWIS batteries will be exhausted before assembly complete is reached. SED will lead the effort to develop and justify a new battery spares plan for re-consideration by the ISS Program Office.

SED continues to support testing at the neutral bouyancy lab to characterize structural loads due to a proposed in-suit pre-breathe protocol. After performing the new protocol for approximately 30 minutes on January 13, a water leak developed at the hard upper torso to primary life support system (PLSS) simulator interface. Investigation showed that leakage was due to nine screws having backed out during testing. The PLSS simulator will be modified to incorporate locking fasteners. Testing will resume January 20.

INSTITUTION - SED completed a next generation micro-wireless system project design package. The project team resolved the final issues enabling the programmable (code) surface acoustic wave (SAW) correlator chip design layout to proceed at Sandia National Laboratories. Fixed (code) SAW correlators, provided by Sandia, are being tested at Invocon, which supports the integrated radio design for units to be delivered in May 2003. The integrated project schedule was updated and contract changes were submitted to Glenn Research Center for approval. The project is preparing for a half-day peer review of the design package and project plan on January 21.

Joseph E. Rogers, Chief

FOR INFORMATION ONLY FROM THIS POINT....

SPACE SHUTTLE - Improved wheel and tire development is progressing on schedule. Tires for certification tests to be conducted at Wright Patterson Air Force Base will be shipped from the vendor within the next few weeks. During the most recent prevention/resolution team (PRT) meeting, it was discovered that no certification leakage tests were required on the new wheel and tire assembly. The NASA program manager due to costs eliminated the extremely expensive certification leak tests from the project. However, the PRT did not realize that even simple, conventional preflight leak tests were not planned to screen for design flaws in "O" ring seal compression. SED has expressed concern with this approach because of past undesirable leakage tests in 1979 on the orbiter wheels where leakage was acceptable at room temperature but was extremely poor at low temperatures. The PRT agrees the simple leakage tests using development hardware must be conducted. (Campbell)

SPACE STATION - SED made a presentation to the mission 12A.1 Joint Operations Panel (JOP) explaining why detailed test objective (DTO) 257 is important to the mission. DTO-257 will excite the structural modes of the mated Shuttle and ISS vehicles. The response of the Shuttle inertial measurement units (IMU) to these excitations will be analyzed to determine if changes to the Shuttle flight control settings can be made to minimize propellant use. The 12A.1 JOP agreed performing DTO-257 is beneficial and will work to accommodate it in the schedule. (Grygier)

SED met with Automation and Robotics Division (ARD) to continue work related to their Trick-based model commonality effort. The Trick simulation environment is a suite of software utilities that allow users to rapidly develop, integrate, and operate simulations based on the application domain. SED is involved as lead for the contact dynamics modeling domain and as a representative external customer. Results from this effort should greatly improve efficiencies in ability to jointly develop integrated Space Station remote manipulator system (SSRMS) and berthing analysis tools. (Briscoe)

SED continued integration of Trick-based berthing mechanism models into the Canadian Space Agency (CSA) SSRMS simulation. A detailed planning session was held with MDR/Robotics, Dynacs, and the CSA. Existing plans were modified by splitting the work into a near-term and long-term phase. The near-team phase will focus on integrating the Japanese exposed facility berthing mechanism (EFBM) with a limited interface. The bulk of this integration will occur next week, as SED will be working with local Dynacs robotics experts to get an integrated simulation running. A limited set of validation work will follow with a goal to have a simulation ready to support analysis in early February. The team will be in a better position to plan the long-term phase after working through the process of the near-term phase. (Briscoe)

SED met with ARD to discuss the results of berthing analysis for flight ULF-1. On this flight, the external stowage platform (ESP) will be berthed to the airlock using the external stowage attachment device (ESPAD). (Briscoe)

SED made a presentation on the micro-gravity requirements for the advanced resistive exercise device (ARED) to the Government Furnished equipment (GFE) Control Board (GCB). The presentation was well received. Subsequently, SED organized a meeting between the ARED project and micro-gravity teams to determine the next steps for issue resolution. Results from the last analysis showed significant improvement using the corrected math model. The ARED project team will make some modifications to the current design for the next round of analyses. SED developed design equations for the current design to assist in this effort. (James)

SED was provided a copy of a stress report for the mini-pressurized logistics module (MPLM) rack-front stowage assembly seat track attach point. The analysis showed a negative structural margin-of-safety. However, a test was performed that showed more capability than was assumed in the analysis. SED supported the STS-114 FAR to discuss this topic. (James)

INTSITUTION - The Vibration and Acoustic Test Facility completed an acoustic emission test on the total organics carbon analyzer (TOCA). Acceptance vibration tests were completed on the 3-point latch tools. Many previously scheduled tests have been delayed due to customer test articles not being ready. These tests have been rescheduled. However, we did work in a high priority (next flight) vibration test for the high strength bridge clamps and also completed some maintenance and cleanup activities in the general vibration laboratory. (Gillette)

Michele Lewis

From: Madera, Pamela L [pam.l.madera@usahq.unitedspacealliance.com]
Sent: Friday, January 17, 2003 4:44 PM
To: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Subject: RE: STS-107 Long Range Tracking Video Screening

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

(I can receive a short alpha numeric page by addressing e-mail to:

-----Original Message-----
From: Madera, Pamela L
Sent: Friday, January 17, 2003 2:46 PM
To: ROCHA, ALAN RODNEY
Subject: FW: STS-107 Long Range Tracking Video Screening

Rodney,
Wanted to make sure you have heard about this. Mike is talking to his group to see what they can do parametrically. Dennis Chao is in contact with Carlos Ortiz/Boeing SI Aero to see if they will be turning on an assessment of the impact. More to come.

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

-----Original Message-----
From: Madera, Pamela L
Sent: Friday, January 17, 2003 1:43 PM
To: Norman Ignacio (Nacho) (E-mail); CHAO, DENNIS
Cc: Michael J Dunham (E-mail); ALEXANDER, ED
Subject: FW: STS-107 Long Range Tracking Video Screening

We may be getting questions on the following report. I looked at the video on the web site (note that the URL wraps around and you have to copy and paste the end of it), but I find it hard to see where the impact is. Looks like they will be reviewing more film over the weekend.

Pam Madera

Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

-----Original Message-----
From: DISLER, JONATHAN M. (JON) (JSC-SX) (LM)
[mailto:jonathan.m.disler1@jsc.nasa.gov]
Sent: Friday, January 17, 2003 12:56 PM
To: Armando Oliu (E-mail); BAHR, PATRICIA A. (PAT) (JSC-SJ) (NASA); BARBARA A. CONTE (JSC-DM) (E-mail); Bill Lamkin; BOBBIE G. SWAN (JSC-CA) (E-mail); Brenda Eliason; BRIAN K. BALU (JSC-NC) (E-mail); Carlos Ortiz-Longo; Chris "The Man" Cloudt; Chris Hadfield (E-mail); Chris Lessmann; Christine Boykin; Curt Larsen / MS2; Dan Clements / NC-GH2; David Brown / CB (STS-107); David Moyer / MER Manager (E-mail); DAVID R. BRETZ (JSC-SN) (E-mail); David Rigby / MPS SSM (E-mail); DENA S. HAYNES (JSC-EV) (E-mail); Don Prevett; DONALD L. (DON) MCCORMACK (JSC-MV) (E-mail); Doug White; Douglas Powell (MAF); FRED F. MAYER (JSC-NC) (E-mail); Gail Hargrove Boeing-Houston Imagery Scrn.; Greg Katnik; Gregory Galbreath; GREGORY J. BYRNE (JSC-SN3) (E-mail); JAMES B. (BRITT) WALTERS (JSC-SF2) (E-mail); 'James Feeley' (E-mail); James Walters; JAVIER J. JIMENEZ (JSC-EA) (E-mail); Jeff Goodmark (E-mail); Jene Richart / MS2; Jill Lin; Jim Harder; 'John McKee' (E-mail); John Ventimiglia; JONATHAN M. (JON) DISLER (JSC-SN) (E-mail); Jorge Rivera; Julie Kramer; Karen Alfaro (E-mail); KENNETH L. BROWN (JSC-MV) (E-mail); KEVIN L. CROSBY (JSC-SN) (E-mail); 'L Lohrli' (E-mail); Malcolm Glenn; MARK D. ERMINGER (JSC-NC) (E-mail); Mark Erminger; MARK L. HOLDERMAN (JSC-MS) (E-mail); MARSHA S. IVINS (JSC-CB) (E-mail); MARTINEZ, HUGO E. (JSC-NC) (GHG); Michael Anderson / CB (STS-107); MICHAEL W. SNYDER (JSC-SN) (E-mail); Mike Cagle / Boeing Film Screen; Mike O'farrell; P J. (JEFF) BERTSCH (JSC-DD) (E-mail); Pam Madera (E-mail); PAUL F. DYE (JSC-DA8) (E-mail); PAYNE, ROBERT W. (JSC-SA13) (LM); 'Philip Kopfinger' (E-mail); Philip Peterson / Boeing Film Screen (E-mail); Philip Reid / Boeing Film Screen; PREMKUMAR SAGANTI PhD (JSC-SN) (E-mail); RANDALL W. ADAMS (JSC-MS2) (E-mail); RAYMOND T. (RAY) SILVESTRI (JSC-DM4) (E-mail); Rick Husband / CB (STS-107); Robbie Robbinson; Robert Page; ROBERT SCHARF (JSC-SN) (E-mail); Robert Speece; ROBERT W. FRICKE JR (JSC-MV) (E-mail); Rodney Rocha / ES2 (E-mail); Rodney Wallace; Rohit Dhawan; Ronald Clayton / MS2; Roy Glanville; Rudy Ramon; SA REP; Sara Brandenburg; Scott Otto; Stephen Frick / CB; Steve Derry; Tom Rieckhoff; Tom Wilson; 'Treith' (E-mail)
Subject: STS-107 Long Range Tracking Video Screening

JSC STS-107 Launch Screening - Long Range Tracking Videos

January 17, 2003

JSC Image Science and Analysis Group Human Exploration Science Office / SX

ANOMALY

ET204, ET208, ET212 - During ascent at approximately 81 seconds MET, a large light-colored piece of debris was seen to originate from an area near the ET/Orbiter forward attach bipod. The debris appeared to move outboard in a -Y direction, then fell aft along the left Orbiter fuselage, and struck the leading edge of the left wing. The strike appears to have occurred on or relatively close to the wing glove near the Orbiter fuselage. After striking the left wing the debris broke into a spray of white-colored particles that fell aft along the underside (-Z side) of the Orbiter left wing. The spray of particles was last seen near the LSRB exhaust plume.

Still views and a movie loop of this event are being placed on our web site for viewing at the following address:

<http://sn-isag.jsc.nasa.gov/shuttleweb/mission_support/sts-107/launch_video/107launchvideo.shtml>

The times of this event are as follows:

Debris first seen near ET/Orbiter forward attach: 016:15:40:21.699 UTC
Debris contacted left wing:
016:15:40:21.882 UTC

Screening of the high speed and high resolution long range tracking films that may show more detail of this event will begin on Saturday morning, January 18th.

Normal Observations Noted Included:

Vapor off the SRB stiffener rings, recirculation, SRB plume brightening, and slag debris after SRB separation.

NOTES:

The long range video tracking views had very soft focus possibly due to clouds and haze.

SRB separation occurred at approximately 016:15:41:06.558 UTC as seen on camera ET208.

Five long range tracking videos were received and screened. Timing data was received on all of the videos received except ET207.

The launch film screening will be conducted on Saturday and Sunday and a report will be sent to distribution on Monday, January 20, 2003.

Jon Disler / SX3-LM
Joe Caruana / SX3-LM
Eric Nielsen / SX3-HEI